ADVANCED BURNER TECHNOLOGIES

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Diagnostic Test Report

for

Opti-Flow™ Low NO_x Burners

on
Intermountain Power Service Corporation

Delta Unit 2

August 20, 2004

1.0 Introduction

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Intermountain Power Service Corporation (IPSC) Delta Unit 2 is a B&W pulverized coal, supercritical boiler rated at 6,900,000 pounds of steam per hour. This unit fires western bituminous coal originally using 48 OEM dual register low NO_x burners. NO_x emissions with those burners were typically in the range between 0.4 and 0.45 lb/10^6 Btu at full load. Intermountain Unit 2 was retrofitted with 48 ABT's Opti-Flow™ Low NO_x burners during the March 2004 outage. In addition, secondary air duct/windbox turning vanes and baffles were designed and installed in the windboxes in order to correct the existing air mal-distribution and instabilities within each windbox. Modifications to install the secondary air duct vanes and baffles are to be implemented by IPSC during the next outage.

ABT has demonstrated operating NO_x levels at full load to be below 0.33 lb/10^6 Btu with 48 Opti-Flow™ low NO_x burners and one mill out of service; with overfire air port closed.

The purposes of the retrofit are:

1: Minimize NO_x without detrimental effects on boiler performance, reliability and efficiency. ABT guarantees that NO_x will not exceed 0.33 b/10^6 Btu, with overfire air ports closed, at the design excess air of Proposal Section 4.6 and 100% MCR. ABT predicts that NO_x with OFA ports open, with a flow of 20% of the total combustion air, will be less than 0.25 lb/MBtu. NO_x is a function of several fuel variables, primary among them is fixed carbon to volatile matter (FC/VM) ratio and % fuel-bound nitrogen. Figure 1 represents the change in NOx guarantee parametrically in FC/VM against fuel nitrogen content as lb. $N_2/10^6$ Btu.

Note: The guarantee point represents the fuel properties specified in Proposal Section 4.9: 1.2% N_2 and 11.500 Btu/lb corresponds to 1.04 lb $N_2/10^6$Btu.

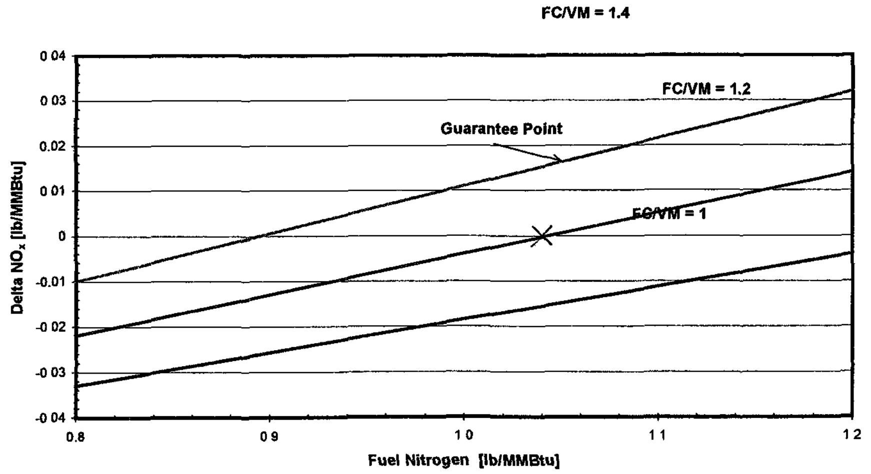

Figure 1 Change in NOx vs. Fuel Properties

2 : Other guarantees

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CO will not exceed an average of 200 ppm, with overfire air ports closed. LOI will not exceed the values obtained in pre-outage baseline testing; with overfire air ports closed with no more than 5% leakage/cooling air flow.

Boiler performance will not be deteriorated from the performance obtained during the baseline tests. Commercially acceptable variations in individual measured data will be acceptable (i.e., super heat temperature ± 10° F, etc.).Boiler efficiency will not be lower than the baseline measurements, corrected for excess air and fuel conditions.

3: Burner Optimization

ABT field service engineers spent 9 days (May 18-26, 2004) assisting plant engineers in tuning IPSC Unit 2 in order to minimize CO. The goal of this tuning was to find one set of burner setting for all mill configurations to meet the CO and NOx limit.

IPSC installed turning vanes and perforated plate inside burner windboxes based on Air Flow Sciences (ASC) model, however there was insufficient time available to install the recommended turning vane arrangement in secondary air supply ducts. Currently the bottom level burners are starved for secondary air. DCS data shows the bottom windbox duct pressure is only 50-60% of the average of the other 3 decks for both front and rear walls as shown in Fig 2.

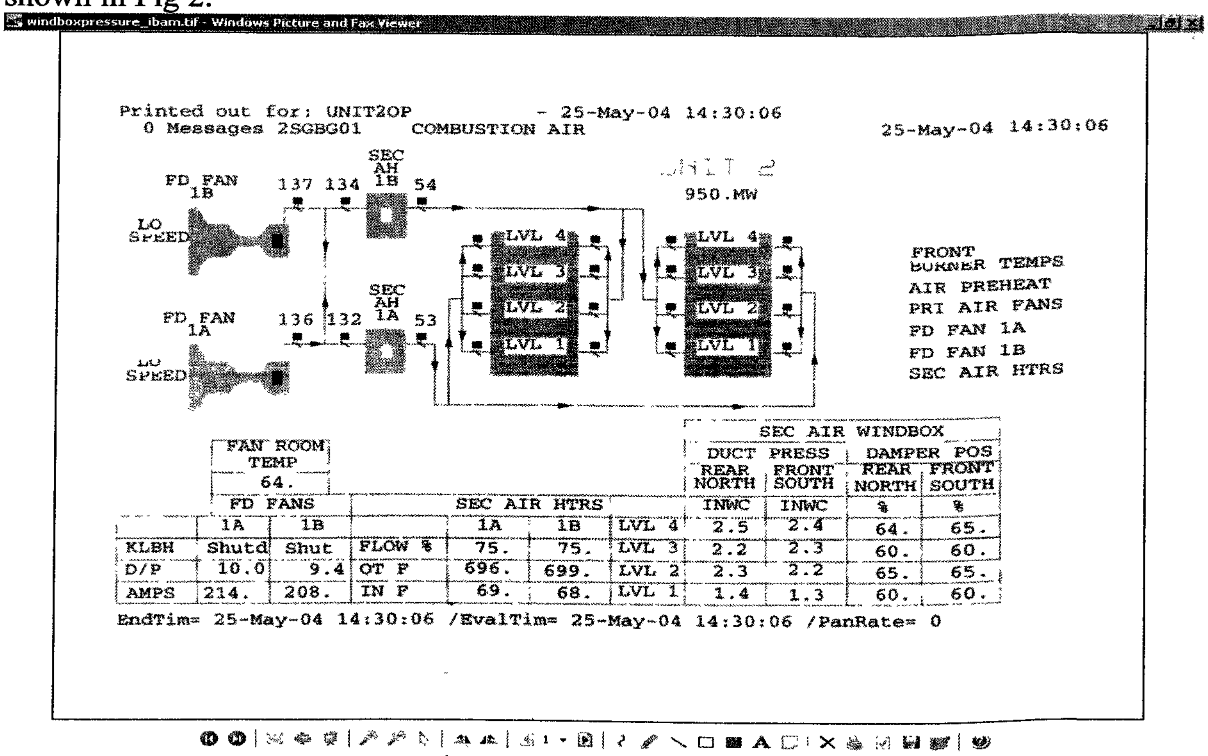

Fig 2 Secondary Air Windbox Pressure

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During the testing the fuel quality changed. In Fig 3 the SO2 changed frequently indicating the change of fuel, and the NOx followed the change.

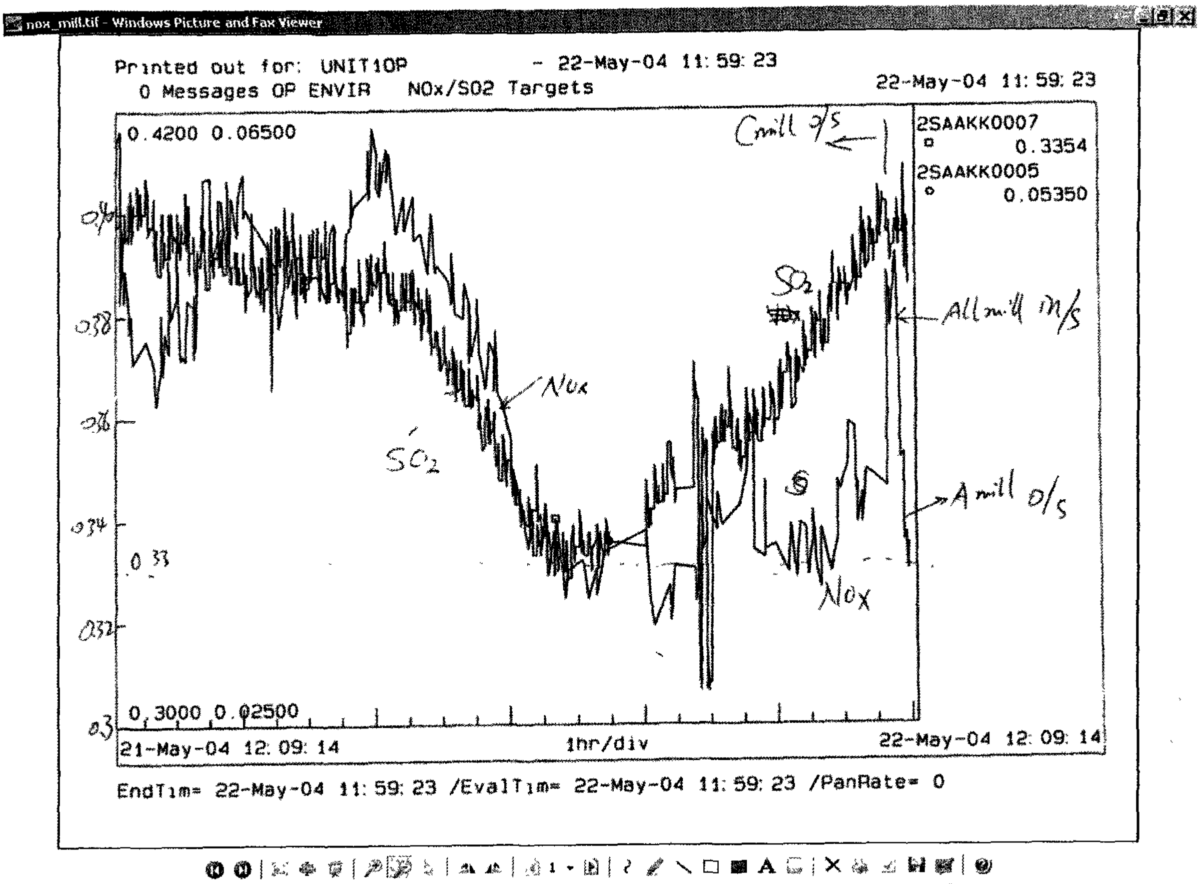

Fig 3 Sulfer Content Changes Indicate Fuel Change

Both sides SA damper control signals are linked, operators can not control west and east SA damper individually which hampers ability to achieve optimum windbox balance.

The gas damper for reheat steam temperature control could redirect the exit gas streamline making it difficult to correlate measured exit gas emissions data to burner location. Also test tap 4 point 4 may have some leakage since the O2 is always high for that probe.

Several Pulverizers require maintenance. Some have differential pressure above 15" WC, this was noted on pulverizers A,C, and E on May21st. Only H mill's differential pressures was noted below 10" WC for all test days.

There were only 2 gas analyzers for CO/O2 (NO_x analyzer not available). The grid was setup according to ASME standard, however with this setup it is difficult to correlate grid data to specific burner columns. Also extracting data from the grid was time consuming with it taking over an hour to generate a test profile with readings fluctuating constantly.

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NOx, LOI, and CO data recorded during ABT test period are summarized in Table 1.

Table 1: LOI and NOx for IPSC Unit2

Time	Nox (cem)	LOI	O2	CO
16-May	0.28	3.5	X	X
17-May	0.26	3.45	X	X
18-May	0.32	4.4	3.23	206.00
19-May	0.29	1.1	3.30	104.00
20-May	0.26	2	3.50	250.00
21-May	0.335	3.75	3.01	206.50
22-May	0.33	3.9	3.36	276.00
23-May	0.34	3.2	3.61	304.00
24-May	0.26	2.6	3.41	281.00
25-May	0.325	X	3.28	304.50
26-May	0.327	X	3.27	157.00

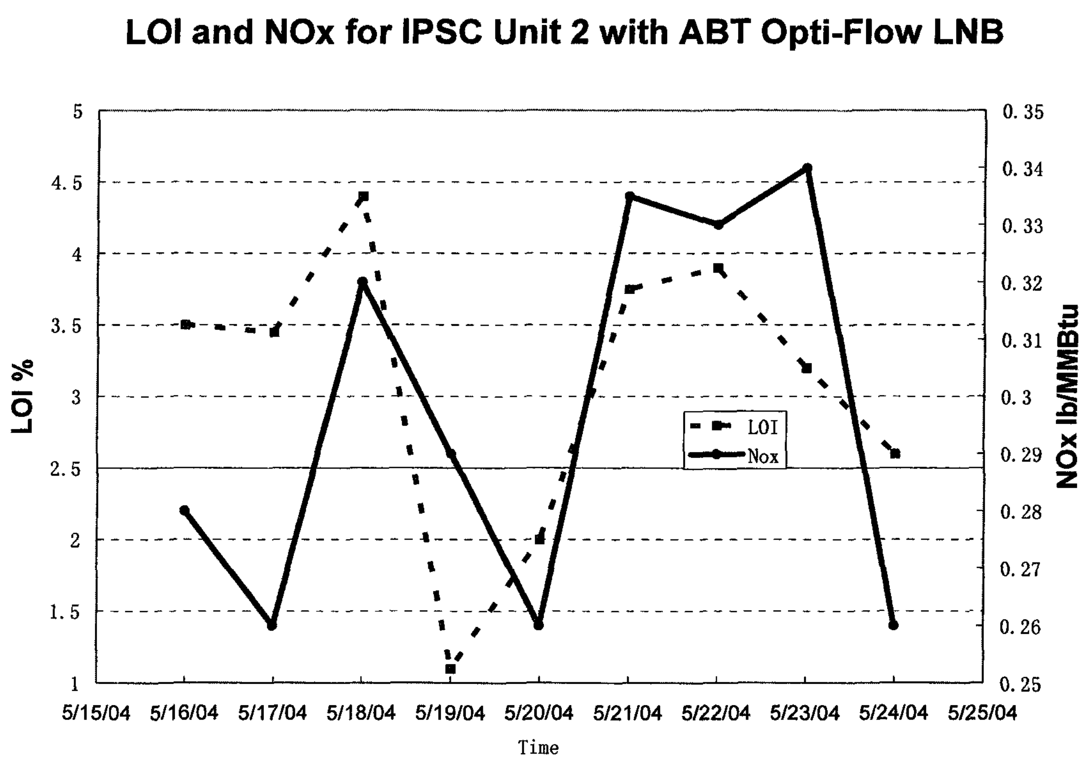

Fig 4 LOI and NOx for IPSC Unit2, Fuel Changed on May 21st

Testing grids were installed according to ASME standard.

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CO and O2 data for all tests (IPSC & ABT test periods) are summarized in Table 2.

Table 2: Overall CO and O2 for All Tests

Testing time	Ave. Grid 02	Ave. Grid CO
April 27 All I/S	3.34	33.395
April 27 All I/S	3.67	17.105
April28 C 0/S	3.78	380.49
April28 D 0/S	3.695	200.315
April29 E 0/S	3.19	662.525
April29 A 0/S	3.055	537.015
April30 H 0/S	3.52	172.555
April30 H 0/S	3.805	69.145
May 3 G 0/S	2.985	830.835
May 3 G 0/S	3.21	649.025
May 3 G 0/S	3.335	595.9
May 4 B 0/S	2.99	743.325
May 4 D 0/S	3.15	691.06
May 4 D 0/S	3.925	395.94
May 7 F 0/S	3.48	614.3
May18All I/S	3.23	206
May19All I/S	3.3	104
May20 F/0	3.5	250
May21 All I/S	2.98	164
May21 C 0/S	3.04	249
May22 C 0/S	3.08	422
May22 A 0/S	3.64	130
May23 H 0/S	3.42	317
May23 H 0/S	3.68	323
May23 H 0/S	3.73	272
May24 A 0/S	3.41	281
May25 All I/S	3.26	317
May25 All I/S	3.09	357
May25 All I/S	3.37	341
May25 All I/S	3.38	203
May26 All I/S	3.3	173
May26 All I/S	3.23	141

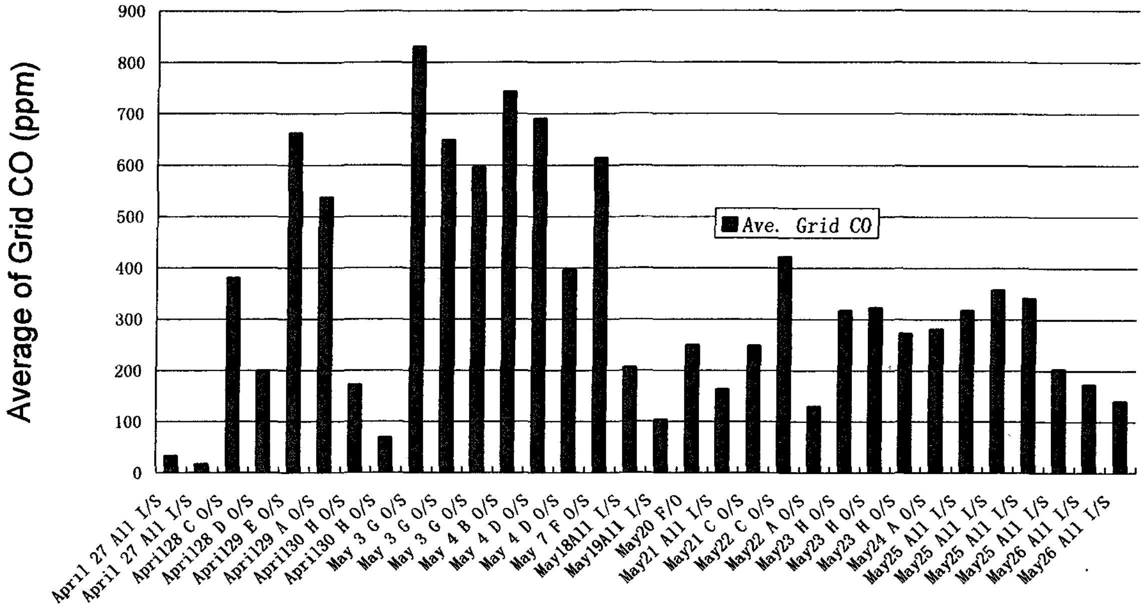

Fig 5 Overall CO

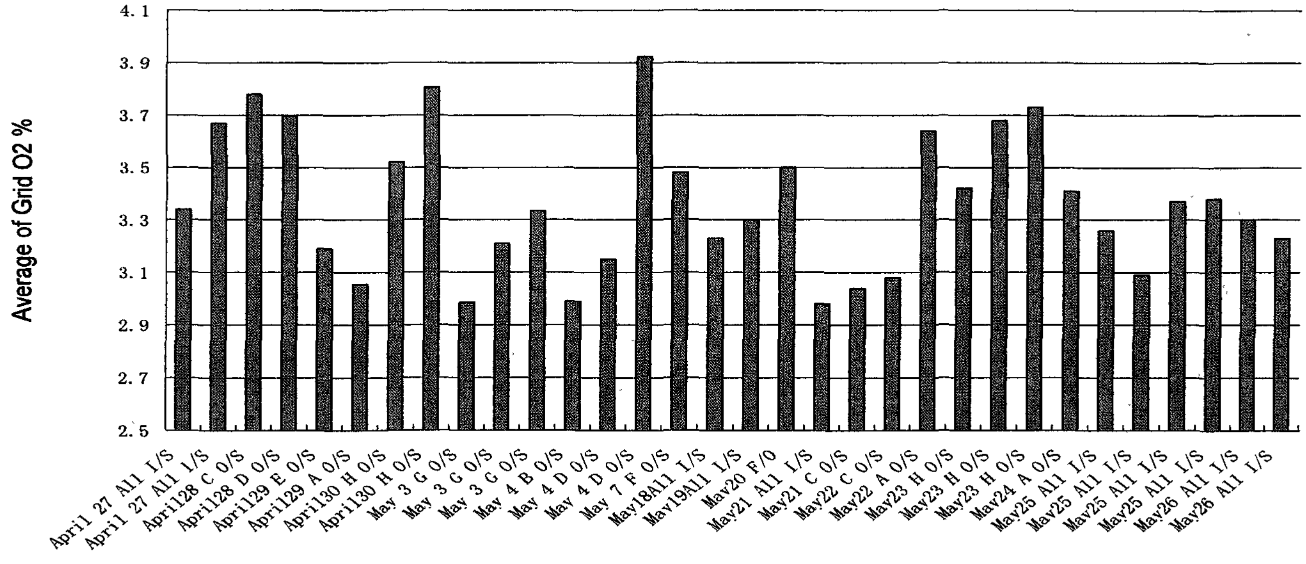

Fig 6 Overall O2

Conclusions:

1. Testing shows that NOx can be controlled on a daily basis below the guarantee 0.33lb/MMBtu.
2. CO can be maintained under 200ppm with all mills in service. Burner settings determined from the 9 days of ABT testing resulted in considerable reduction in the CO emissions, under the various mill out conditions. The optimization process illustrated during the testing was successful in isolated burners that were main contributors to CO formation. Adjusting component settings on these specific burners improved their flames and resulted in reduction in CO emissions on the boiler.
3. Use of a professional testing company would assist ABT field engineers with timely test information in a profile correlated to burner location. This should result in further reductions in the average CO emissions on a daily basis.
4. Installing ABT designed turning vane modifications inside of SA supply ducts will improve flow distribution to bottom level burners. This is key to further reductions in CO emissions for the worst case mill out configurations.
5. Maintaining the coal quality as constant as possible will facilitate obtaining repeatable results during future optimization testing.
6. Unlinking the control signal between east and west side SA dampers will allow greater flexibility to bias the east/west side secondary air, which should help optimize windbox air balance.
7. Performing maintenance on the mills will further improve combustion performance. We are not able to comment on the affect the primary air system has on the emissions in absence of test data related to burner line balance, mill coal fineness, and coal analyses.
8. Installation of additional pressure probes inside existing windboxes test ports on each of the levels would allow measuring of the pressure distribution across the windbox.

Detail test results and burner settings are provided in the Appendix